ployed; but in place of them there are several broad dark bands to which no origins have yet been assigned. Secchi first observed the spectrum in 1869, and he pointed out that, if the luminosity of the planet be due to solar light, it must undergo great modifications in the atmosphere of the planet. Vogel and Huggins re-observed the spectrum and mapped it in considerable detail, Vogel giving the positions of no less than twelve bands. The five principal bands have the following positions:—

618. Darkest part of a broad band, ill-defined towards the red.
596. Middle of a faint narrow band.
573·8. Darkest part of a broad band.
542·5. Middle of darkest band in spectrum.
486·1. Middle of a dark band.

It has not yet been possible to explain any of the dark bands by comparisons with known absorption spectra; one band is certainly coincident with the F line of the solar spectrum, but it is much too broad to be due to reflected sunlight. Prof. Lockyer gave his attention to the spectrum last year, and thought it possible that many of the apparent dark bands were simply contrast appearances due to the presence of radiation flutings. At his suggestion I examined the spectrum, and came to the conclusion that he was right. I afterwards made observations, in conjunction with Mr. Taylor, with Mr. Common's 5-foot reflector. A full account of the results is given in Mr. Taylor's paper on the subject (*Monthly Notices*, vol. xlix. p. 405). We decided in favour of bright flutings, and Mr. Taylor afterwards mapped them very carefully. The brightest fluting is near *b*, and it is remarkable that Secchi noted this brightening in his light-curve of the spectrum. Mr. Espin has since observed that the blue end of the spectrum is broken up into bright bands and dull shadings. If the apparent bright flutings are not contrast effects, as has been suggested, the planet must be to a great extent self-luminous. Dr. Huggins has since photographed the violet end of the spectrum, and finds nothing but solar lines—a fact which is very difficult to explain, when the remarkable character of the visible spectrum is considered.

It is highly important that further observations, by as many different observers as possible, should be made. The apparent diameter of the planet is so small that a Maclean spectroscope shows the bands very well, but the brightnesses are best seen when the spectrum is narrow, as is the case with bright-line stars.

(2) This nebula is thus described in the General Catalogue: "Bright; large; extended in a direction 150°; pretty suddenly brighter in the middle to a resolvable nucleus." The apparent size of the nebula, according to the Harvard College observations, is 3′ × 1′. The spectrum has not been recorded.

(3) This star is one of considerable interest. Dunér says: "It appears to have a narrow band in the red, and a wide one in the green. Perhaps III.*a* (Group II.), but by no means III.*b* (Group VI.)." It has been suggested, from a discussion of the other members of the group, that the star is a representative of the very earliest stage of Group II., but further details are necessary before it can be said with certainty. The condition here should be almost cometary, and hence, in further observations, the bright flutings of carbon should be particularly looked for. So far, this is the only observed star which may possibly belong to the first species of the group.

(4 and 5) These stars are included in Vogel's spectroscopic catalogue. The first is stated to be of the solar type, and the second of Group IV. The usual observations are required in each case.

(6) This variable will reach a maximum about May 20. The range is from 6·4–8·5 to 13 in 255·6 days. The spectrum is one of Group II. (Dunér), the bands being wide, but not very dark. The usual observations for bright lines and other variations are suggested.

A. Fowler

Changes in the Magnitudes of Stars.—At the April meeting of the Royal Astronomical Society Mr. Isaac Roberts presented a photograph of stars in the regions of Tycho Brahe's Nova taken on January 12, with an exposure of 2 hours 55 minutes. D'Arrest charted the stars in the region of the Nova in 1864 down to the 16th magnitude, and this chart has been used by Mr. Roberts to compare with his photograph. He finds no appearance of either a nebula or of a star on the photograph in or about the position indicated by D'Arrest, but a comparison of the chart and catalogue with the photograph shows that changes have taken place both in the positions and magnitudes of several of the stars since 1864. The changes particularized are important when it is considered that they apply to less than half a degree in right ascension, and one degree in declination. That six of the stars shown on D'Arrest's chart and not shown on the photograph, are absent on the latter on account of some physical change having taken place in the stars, receives confirmation from the fact that the photograph shows more than 400 stars on a sky space where D'Arrest has charted only 212 stars.

A Mechanical Theory of the Solar Corona.—Prof. Schaeberle of the Lick Observatory, has propounded an entirely novel theory of the solar corona, a discussion of which will appear in the report of the eclipse of December 22, 1889. His investigations seem to prove that the corona is caused by light emitted and reflected from streams of matter ejected from the sun by forces which in general act along lines normal to the surface. These forces are most active near the centre of each sun-spot zone. Owing to the change of the position of the observer with reference to the plane of the sun's equator, the perspective overlapping and interlacing of the two sets of streamers at these zones causes the observed apparent change in the type of the corona. To roughly test the theory Prof. Schaeberle has stuck a lot of needles in a ball to represent the streams of matter, placed the model in a beam of parallel rays, and allowed its shadow to fall upon a screen, the result being that an infinite variety of forms similar to the coronal structure can be reproduced by simply revolving the model. It remains to be proved whether a comparison of the forms that are seen according as the observer is above, below, or in the plane of the sun's equator, agree with those that should be seen on this theory.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held on Wednesday and Thursday of last week, in the theatre of the Institution of Civil Engineers, the President, Sir James Kitson, occupying the chair. There was a fair programme of ten papers, and another was added after the list had been printed. The following were the papers read:—

On a new form of Siemens furnace, arranged to recover waste gases as well as waste heat, by Mr. John Head, London, and M. P. Pouff, Nevers.

Calculations concerning the possibility of regenerating the gas in the new Siemens furnace, by Prof. Åkerman, Stockholm.

On the critical points of iron and steel, by M. F. Osmond, Paris.

On the carburization of iron by the diamond, by Prof. W. C. Roberts-Austen, London.

The changes in iron produced by thermal treatment, by Dr. E. J. Ball, London.

On the Robert-Bessemer steel process, by Mr. F. Lynwood Garrison, Philadelphia.

Aluminium in carburetted iron, by Mr. W. J. Keep, Detroit.

On certain chemical phenomena in the manufacture of steel, by Mr. W. Galbraith, Chesterfield.

The estimation of phosphorus in the basic Siemens steel bath, by Mr. W. Galbraith, Chesterfield.

On the Rollet process for producing purified castings, by Mr. A. Rollet, St. Etienne.

The first six of these papers were read and discussed at the first day's sitting (Wednesday); and the remaining four were disposed of before lunch-time on Thursday. It is seldom that we have seen papers "rattled off"—the phrase most aptly describes the procedure—in so rapid a manner. The members who were present may certainly be congratulated upon having got through a great many papers in a very short space of time; but it is a question whether there would not have been a gain to knowledge had the discussions been of a somewhat more deliberate nature.

In addition to the above papers there was on the agenda a memoir by Sir Henry Roscoe, on the action of aluminium on iron and steel. This, however, was not forthcoming; a fact which is to be regretted, as also is the cause which led to it, the subject being one of considerable scientific and industrial importance at the present time, when the production of aluminium is being so much cheapened, and such great things are promised by those who advocate its use in the metallurgy of iron and steel. Fortunately Mr. Keep's paper was forthcoming, and this elicited a brief but useful discussion, in the course of which Mr. James Riley, of the Steel Company of

Scotland, and others, gave the valuable information drawn from the practical experience they had gained in the alloying of iron with aluminium on a large scale. We will, however, take the papers so far as space will permit, in the order in which they were read.

Mr. Head's paper was read at the Paris meeting of the Institute, held last autumn, but was not then discussed. The author first points out that, in 1817, the Rev. Robert Stirling and his brother James Stirling applied the regenerative principle to air-engines, and that both they and J. Slater, in 1837, and R. Laming in 1847, foresaw the possibility of its application to metallurgical operations. The new Siemens furnace, which was the subject of the paper, was described and illustrated by wall-diagrams, without reproducing which it is not possible to make the arrangement clear. The chief point is that the waste gases are reconverted into combustible gases by being taken partly through an air-regenerator, and partly under the grate of the producer, so that they distil the hydrocarbons from the coal; in fact, the gas-producer utilizes the heat formerly deposited in the air regenerators. A steam jet is used for starting the action. This new form of regenerative gas-furnace has been applied to the heating and welding of iron. It is to be used for puddling, and for copper and steel melting. It is claimed that it effects a saving in fuel of about two-thirds the weight, a reduction in the weight of iron equal to 5 per cent., and a saving in labour and repairs. Figures were quoted supporting these claims.

Prof. Åkerman's paper was a discussion on the theory of combustion raised by the process. The subject is one of considerable interest, and is well put forward by the author. His conclusions are of considerable interest from a philosophical point of view, but are to a great extent robbed of their importance from an operative standpoint, from the uncertainty existing upon the specific heat of gases at high temperatures; which is only one more fact emphasizing the want of a proved and trustworthy pyrometer.

A brief discussion followed, in which Sir Lowthian Bell took the chief part.

M. Osmond's paper was one of those which must be the despair of the writers of brief notices such as this. It consisted of 33 pages, giving results of experiments made to ascertain the effects of varying temperature on different alloys of iron. In the presence of such a mass of matter as this we can only refer our readers to the Transactions of the Institute, where they will find the facts detailed and the diagrams by which they were illustrated fully set forth. We will content ourselves with simply stating that the "critical points" are points of arrestation in the cooling of iron and steel. It is interesting to notice the effect of various alloys on this phenomenon. Perhaps, to those members who were not previously acquainted with the instrument, the description of the thermo-electric pyrometer of Le Chatelier was not the least interesting part of the paper. A valuable bibliography is given in an appendix. In the discussion Mr. Wrightson gave some particulars of experiments he had made to ascertain the change of volume of iron at different temperatures, which he did by plunging an iron ball into liquid iron. The ball would at first sink, but rise as it acquired heat, and indications were thus obtained, which appeared to correspond with the "critical points" of the author. Mr. Hadfield also made some interesting remarks on the state of carbon in iron.

Prof. Roberts-Austen's paper followed. The Professor is not, of course, the first to carburize iron by means of the diamond; indeed, it has been a somewhat favourite experiment, with which the name of more than one eminent physicist in times past has been associated. But Prof. Roberts-Austen is, we believe, the first to perform the operation *in vacuo*, the iron itself being previously heated *in vacuo* to deprive it of its occluded gas. The author of the paper refers to the experiments of Hempel, who heated diamond and iron in an atmosphere of nitrogen perfectly free from oxygen, and points out that his, the author's, experiments are interesting from the assertions made by a certain school of chemists that no two elements can react on each other unless a third be present. "It would appear, however," Prof. Roberts-Austen says, "that a mere 'trace' of such additional element is sufficient to insure combination; for, in the experiments I have described, carbon and iron in their purest obtainable forms were used, and the only additional matter which could have been present was the trace of occluded gas which the iron may possibly have retained." The author is satisfied that combination does not take place until a full red heat is reached.

Dr. Ball's paper dealt with the changes in the magnetic capacity and tensile strength of steel which occur at definite temperatures, and showed how these changes may be made evident when the metal is rapidly cooled in water or in oil. Two samples of steel, one basic Bessemer and the other acid open-hearth, were submitted. Analysis showed that all the elements for which tests are usually made were almost identical, except manganese, of which the percentages were 0·284 for Bessemer, and 0·546 for open-hearth. The results are plotted on three sets of diagrams, one diagram in each set showing the results obtained with tests hardened, from varying temperatures, in water, in oil, and annealed respectively; the sets of diagrams refer to unstrained bars, the same bars strained to the yield point, and the same bars strained almost to the breaking point. These last two papers were discussed together.

Mr. Garrison's paper was read at the Paris meeting of September last, but not then discussed. It describes an elliptical converter in which the *tuyères* are so arranged that they blow air at the surface of the metal in a manner which causes a rotary motion of the bath, combustion taking place at the surface. The device is not altogether new, as surface blowing was suggested, and, indeed, patented, by Sir Henry Bessemer in the early days of the Bessemer process.

Mr. Keep's paper on aluminium, in carburetted iron, was the first taken on the Thursday morning. In it the results of certain tests were given, the details being set forth in graphic form. The points noted were strength to resist both weight and impact, deflection, set, elasticity for stresses applied, shrinkage for cast metals, hardness, and rigidity. This paper must be read with others that have been brought forward by the author, whose work in connection with the subject is well known. As a general result the tests go to show that the effect of a proper quantity of aluminium on commercially pure iron is to produce a material which is soft, easily bent, and flows readily. Aluminium diminishes deflection by decreasing the set and elasticity. Rigidity is also increased, the grain is closer and more uniform; in short, the author claims that by aluminium the metal is improved in every way when considered as a structural material.

In the discussion which followed the reading of the paper, Mr. James Riley, the manager of the Steel Company of Scotland, said that he had tried the effect of aluminium in steel on a large scale, but had been disappointed in the results. There were advantages, but these were so slight as to be insufficient to pay for the additional expense of one to two pounds a ton. Fluidity was gained, tensile strength was very slightly increased, the elastic limit was raised considerably, and ductility was increased. If aluminium could be reduced sufficiently in price it would be good to use it, but Mr. Riley had not considered the game worth the candle, and had ceased to use it a year ago. He had, however, been induced lately, by being told of the wonderful results obtained, to make further experiments, but his present frame of mind was not to use aluminium excepting for very fine thin castings. Mr. Spencer, of Newburn, another large steelmaker who has achieved great success in certain special branches of manufacture, endorsed what Mr. Riley had said. Mr. Allen pointed out that there might be traces of aluminium in pig-iron without its being discovered, as chemists only tried, as a rule, for the usual alloys. It was also important to remember that although aluminium might be put into the pot it did not necessarily appear in the product, as it might be removed by chemical reaction during the process. The latter point was supported by Dr. E. Riley and Mr. Stead.

Mr. Galbraith's two contributions were next read and discussed, but do not call for any special mention. Finally, Mr. A. Rollet's paper was read, in which his process of obtaining purified metal for castings was described. The process was illustrated by diagrams, and may be said briefly to consist of eliminating from pig-iron, to be used for the manufacture of particular qualities of steel, sulphur, phosphorus, and silicon. The pig is placed in a special cupola, and is maintained at a very high temperature under a double action, slightly reducing and slightly oxidizing, in the presence of a slag obtained by admixtures of limestone and lime, iron ores, and fluor-spar. By the arrangement of the cupola the metal is separated from the slag as soon as they are removed from the action of the blast in tapping. In this way the phosphorus already eliminated is prevented from going back into the metal, and too great a recarburization is also avoided. The elimination of sulphur is complete up to 99 per cent. and even more; that of phosphorus amounts to 80 or 85 per cent., or even 90 per cent. and more.

A short discussion followed the reading of the paper. The only important point brought forward, however, was a statement by Mr. Hugh Bell that, at Clarence, they had been carrying on a process almost identical with that described by the author. Had he, the speaker, been aware that the plan was in use elsewhere, and had he known a paper was to be read on the subject, he would have come provided with certain figures bearing on the matter.

The meeting then broke up after the usual votes of thanks had been duly passed.

The autumn meeting of the Institute is this year to be held in America. The meeting will be held in New York, and we hear rumours of vast preparations that are being made by the hospitable metallurgists and engineers of the United States to welcome their British *confrères*. Members are left to make their own way to New York, but upon landing they become the guests of the American Institute of Mining Engineers. From an outline programme we have seen, it would appear that the only limit to the excursion will be the time at the disposal of members, which, those who know American hospitality best will agree, is sure to be exhausted long before the good-nature of their hosts.

We should have stated before that Mr. W. D. Allen, of Sheffield, this year has been awarded the Bessemer Gold Medal. Mr. Allen was associated with Sir Henry Bessemer in the manufacture of Bessemer steel from the very first. Indeed, he may be said to have been present at the birth of the invention, and was fully acquainted with the whole process before a single patent was taken out.

A MONUMENT TO A FAMOUS JAPANESE CARTOGRAPHER AND SURVEYOR.

THE *Japan Weekly Mail* contains a report of the unveiling of a monument in Tokio on December 14, 1889, to the memory of Ino Chukei, a Japanese cartographer and surveyor of the early part of the present century. The ceremony was performed by Prince Kitashirakawa, President of the Tokio Geographical Society. The name of Ino Chukei was first made familiar to the Western world by Dr. Naumann, the organizer, and for many years the head of the Geological Survey Bureau of Japan. More lately, Dr. Knott wrote two short biographies of Ino, the one published in the Transactions of the Asiatic Society of Japan (vol. xvi., 1888), and the other as an appendix to the memoir on the recent Magnetic Survey of Japan, published in the Journal of the College of Science, Imperial University (vol. xi., 1888). Ino was by profession originally a brewer, and did not begin his scientific life till he was past fifty. The story of the enthusiastic septuagenarian travelling over the length and breadth of Japan with his quadrant, his azimuth circle, his compass, and his clock is almost a romance. His latitude measurements are still of importance to the cartographer, and his map of Japan has formed the basis of every map since constructed. He finished his grand survey in 1818, after 17 years of travelling and observing. And now, nearly seventy years after his death, a lasting memorial has been raised at Shiba, in Tokio. The ceremony of unveiling the monument began at 2 p.m. on December 14, in the presence of a large company. Amongst those present were Prince Kitashirakawa, Viscount Sano, Viscount Enomoto, Admirals Akamatsu, Nakamuta, and Yanagi, Mr. Hanabusa (Councillor), Mr. Arai, Director of the Meteorological Office, Mr. Watanabe, President of the Imperial University, many of the University Professors, and others. The Chinese Representative, the German Minister, M. Dautremer, of the French Legation, and Profs. Burton, Divers, and Knott, may be named as the diplomatic and scientific representatives of foreign nations. The Naval Band was in attendance, and filled the intervals between the different parts of the celebration with selections of music. Four Shinto priests first went through a religious ceremony, which consisted chiefly of purificatory rites, and an invocation to the spirit of Ino. Mr. Watanabe then read a report, giving a history of the movement, which originated seven years ago with the members of the Tokio Geographical Society, and culminated in the ceremony of the day. The original desire had been to put up the monument on the site of the spot where Ino made the first observations in his grand survey—that is, the point through which the zero meridian was taken. This was at Shinagawa. But it had been found more convenient to raise the memorial at Shiba, within sight of this first station. The monument, designed by Prof. Tatsuna, of the Imperial University, and cast in bronze at the Kawaguchi Foundry, had cost nearly 3800 dollars. The whole of the expenses had amounted to about 4000 dollars, which had been met by voluntary subscriptions from the members of the Geographical Society and many others who desired to contribute their mite. The monument, a graceful obelisk of a dull green tint, was unveiled by Prince Kitashirakawa, a translation of whose speech runs thus:—"What an achievement in cartography was that of learned Ino Chukei! During the eras of *Kansei* and *Bunsei* (1790 to 1820), when Japan, at peace within her own borders, isolated from intercourse with the outer world, divided into a number of mutually-secluded fiefs, and, undisturbed by the cares of coast defence, was content with her own littleness, Ino, his fiftieth year already passed, commenced the study of geodesy, and, equipped with instruments of his own manufacture, devoted eighteen years of toil and suffering to the survey of the empire, bequeathing to posterity the memory of a truly great work. From the point of view of strategical advantage, from the point of view of the progress of civilization, from a domestic as well as from a foreign point of view, Ino undoubtedly was a credit to his country. His name is on the lips of the whole nation. The Emperor himself has bestowed posthumous rank on him and presents on his descendants. Japanese and foreigners have contributed to erect to his memory a monument of dimensions unparalleled in Japan. And it is a privilege conferred on me in this enlightened era that, as President of the Tokio Geographical Society, I am permitted to speak of his achievements and to unveil his monument. I rejoice greatly to take part in this imposing ceremony, and I am persuaded that the spirit of Ino in heaven will share the satisfaction which his posterity must feel on such an occasion. Reverentially, on behalf of this Society, I unveil the monument. May the fame of the illustrious dead grow with the growth of our country's civilization."

After some minutes' interval, Viscount Sano advanced to the foot of the steps that lead up to the pedestal, and introduced to the audience the great-great-grandson of Ino, who bowed and expressed the gratitude of the family for the honour done to their ancestor. Viscount Sano then gave a short biographical sketch of Ino, and an account of his great labours, for which he had earned the never-dying gratitude of his countrymen. This ended the ceremony. Later on, in the rooms of the Geographical Society, a select party assembled to inspect the rude instruments with which Ino carried out his observations. The obelisk is very graceful in form, and beautiful in its setting. As already mentioned, the colour is pleasing, and the inscription is artistic as only an ideographic inscription can be. The monument is 34 feet high, the obelisk itself being 27 feet. A flight of steps ascends to a square platform of masonry in the centre of which the pedestal rests. A railing, the bars of which are curved and puckered up so as to represent sea and clouds according to a common Japanese convention, runs round the outer edge of the platform and down the sides of the steps, allowing free ingress and egress to the pedestal and obelisk. The obelisk faces nearly south, and in its back is a door by which access can be gained to the interior. It is intended to place inside the instruments already spoken of, which were used in Ino's survey.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 1.—"The Development of the Sympathetic Nervous System in Mammals." By A. M. Paterson, M.D.

At the present time two opposite views exist among embryologists regarding the development of the sympathetic system. In both, the segmental formation of the sympathetic cord is upheld. According to the view of Remak and others, it is mesodermal, and formed *in situ*. According to the other view, it is ectodermal. Balfour and Onodi, who have maintained the latter view, differ, however, as to the fundamental origin of the sympathetic system—Balfour regarding each sympathetic ganglion as an offshoot from the spinal nerve, while Onodi considers it as a direct proliferation from the spinal ganglion.

For the present research, mammalian embryos were exclusively employed. The stage in development was first considered in